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## DECLARATION

I, Patrick Chaumette, a technical translator of INSTITUT FRANCAIS DU PETROLE 1 & 4, Avenue de Bois Préau 92852 RUEIL MALMAISON FRANCE, do hereby declare that I am conversant with the French and English languages and I certify that the following translation made by me is to the best of my knowledge and belief a true and correct translation of the authentic text of the French priority document **n° 01/01.840** filed on 12 February 12, 2001.

Patrick Chaumette

Signed this Tuesday, 28 March 2006

# DEVICE COMPRISING RECYCLING TO A SEPARATOR A LIQUID EFFLUENT OBTAINED FROM AN ABSORBER AND MIXED WITH A FEEDSTOCK

The invention relates to a device allowing the recovery of light hydrocarbons, for example hydrocarbons that have a number of carbon atoms of between 2 and 6 (C2 to C6 hydrocarbons), in particular hydrocarbons that are obtained from a petroleum fraction and that are called Liquefied Petroleum Gas or LPG (according to English terminology), essentially comprising C3 and C4 hydrocarbons optionally with a few C2 and/or C5 hydrocarbons. The invention also relates to a device for recovery of a hydrogen-enriched gas. Any gas that comprises hydrogen and light hydrocarbons can be treated in the device according to the invention, for example the purge gases that are obtained from units for conversion of petroleum fractions or from fractions that are obtained from natural gas.

The invention also relates to the processes for recovery of light hydrocarbons or a hydrogen-enriched gas that uses a device according to the invention.

## Background of the Invention

Patent US 5,326,926 describes a process for isomerization of C4-C6 paraffins and for recovery of LPG-type hydrocarbons, essentially C4 hydrocarbons. This process comprises an isomerization followed by a stabilization column that produces a separation of the effluent obtained from the isomerization unit into 4 fractions and a stripping of one of the intermediate fractions to collect hydrocarbons that have 4 carbon atoms. This process does not include an absorption column.

Patent EP 0 488 757 B1 describes a process for isomerization of a flow that comprises C5-C6 hydrocarbons. Said process comprises an isomerization zone, a deisohexanization zone that provides at the top methyl and dimethylbutane and normal pentane that are sent to a selective adsorption unit in which the normal hydrocarbons

are adsorbed, a lateral fraction comprising normal hexane and methyl pentanes recycled for isomerization and a fraction comprising hydrocarbons with a boiling point higher than that of normal hexane. A desorption stage allows recovery of normal hydrocarbons that are recycled in the isomerization unit. This process comprises adsorption and desorption stages, preferably by variation of pressure with a P.S.A. (Pressure Swing Adsorption according to English terminology, i.e., adsorption by pressure variation) but does not include an absorption stage. It no longer comprises a cooling stage and is optimized for separating the normal paraffins from isoparaffins after isomerization.

Patent US 5,238,555 describes a process for purification of hydrogen by treatment of an effluent containing hydrocarbons and hydrogen and obtained from a hydrocarbon conversion unit. This process comprises a fractionation of the effluent into a liquid phase and a vapor phase, followed by an indirect exchange in a gas/gas exchanger with a hydrogen-rich gas as far as the vapor phase is concerned and an exchange with a hydrocarbon-containing liquid as far as the liquid phase is concerned. The two liquid and vapor flows are then cooled in two separate cooling zones, then sent independently to said absorption unit that operates in countercurrent.

**Summary of the Invention**

The invention relates to a device and a process for recovery of light hydrocarbons in a gas or a mixture of gas and liquid, for example in a gaseous fraction that is obtained from a natural gas or a petroleum fraction, or in a purge gas from a hydrocarbon conversion unit such as, for example, a unit for hydrogenation, hydrotreatment, hydroconversion, isomerization or cracking. The invention also relates to a process and a device for recovery of a hydrogen-enriched gas.

In general, the device according to the invention comprises at least one absorber, at least one cold separator from which is extracted a gaseous phase that feeds the

absorber, at least one recycling to said cold separator of at least a portion of the liquid effluent that is obtained from the absorber and is mixed with the feedstock, at least one cooling means (or system) of said recycling, at least one means for recovery of a light hydrocarbon-enriched liquid fraction that is obtained from said cold separator and at least one means for evacuating gases from the absorber. Furthermore, the gaseous fraction that emanates from the absorber is high in hydrogen when a conversion unit that functions in the presence of hydrogen is used upstream from the separation device according to the invention. The optimization of operating conditions and the sizing of the equipment therefore makes it possible to use the device according to the invention for the production of a hydrogen-rich gas and/or for the production of a light hydrocarbon-enriched liquid.

The separator is preferably located under the absorber, and more preferably the separator and the absorber consist of two sections that are superposed inside the same piece of equipment. For example, in the device according to the invention, it is preferably possible to use a separator tank (Flash tank according to English terminology) that is surmounted by a column whose height and diameter are adjusted based on the targeted application and the composition of the feedstock. Said column is preferably at least partially filled by bulk packing systems, for example so-called Rachig rings or packing rings that are marketed by the PALL Company (PALL rings), or else using more structured packing such as that produced by the SULZER Company (SULZER packing). Such equipment comprising a separator (D1) surmounted by an absorber (C1) with internal packing (5) is shown in Figure 1.

According to a preferred variant, the device according to the invention further comprises recycling of the liquid fraction obtained from the separator and at least one cooling means (or system) as part of said recycling.

In addition to all of the means described above and according to other variants, the device according to the invention optionally can comprise cooling systems that are

preferably conventional, such as, for example, those using at least one water coolant or at least one coolant gas and/or a fractionation column allowing fractionation of the liquid effluent obtained from the cold separator into at least two fractions, preferably at least 3 fractions, one of which constitutes, at least in part, the liquid phase recycled to the absorber.

It is also optionally possible to recover directly a portion of the liquid effluent obtained from the absorber without recycling this portion to the cold separator.
The device according to the invention can optionally further comprise at least one exchanger allowing exchange of calories between the liquid phase that is obtained from the cold separator and the liquid phase that is recycled to the absorber after fractionation in the column. The different liquid flows can also comprise at least one pump helping in the recirculation of at least one liquid flow. These variants can be combined and are then particularly well suited to the case where the feedstock treated in the device according to the invention is obtained from an isomerization unit.

The effluent enriched with light hydrocarbons with the device according to the invention is collected either directly at the outlet of the cold separator or at a lateral outlet of the fractionation column when the latter is present.
In this example, vapor phase 8 of cold separator D1 passes in countercurrent through an absorber C1 where it comes into contact with a lean solvent 2 (i.e., a liquid that is low in light hydrocarbons) that is first cooled in cooling system RF2. Absorber C1 preferably contains a solid 5 that facilitates the absorption, such as, for example, Rachig rings.

The rich solvent or liquid obtained from the absorber and enriched with light hydrocarbons that absorbed light hydrocarbons 3 is mixed with purge gases 1 (feedstock) and 6 (recycling of column C2), in which it is desired to recover said light hydrocarbons.

This mixture is cooled in refrigeration system RF1 before joining separator tank D1 located at the bottom of the absorber. Gaseous phase 8 of separator D1 that is low in light hydrocarbons feeds the bottom of absorber C1. Liquid phase 9 of separator D1 containing the light hydrocarbons is directed via line 10 and with pump 11 and line 12 to a thermal exchanger E1, then via line 13 into exchanger E2, then finally via line 20 to separation column C2, in which the light hydrocarbons are separated from the rich solvent to be recovered at the top of the column via line 22 and cooled in cooler 23 to obtain the light hydrocarbon-enriched liquid phase in liquid form in 24. Column C2 shown in Figure 1 comprises at the top an internal condensation system. This system optionally can be replaced by external recycling and an external condenser.

The bottom of column C2 consists of the regenerated lean solvent that is recycled to absorber D1. This recycling is carried out successively via line 15, thermal exchanger E2, line 16, cooler 17, line 20, exchanger E1, line 21, cooling system RF2 and finally line 2.

It is optionally possible and preferred to eliminate via line 18 a portion of the lean solvent and to mix a liquid fraction, fed via line 19, with the lean solvent fraction recycled to the absorber. This liquid fraction can be, for example, a fraction that is obtained from a deisohexanizer, a kerosene, a gas oil, a heavy reformate (heavy fraction that is obtained from a reforming unit) or else a heavy naphtha.
The bottom of the column is equipped with a reboiler that comprises lines 25 and 28 and preheater 26.

Purge gas 6 of column C2 is also recycled in absorber C1 to improve the recovery rate of light hydrocarbons. The residual gas that is low in light hydrocarbons 7 is purged at the top of absorber C1.

The cooling level of cooling systems RF1 and RF2 is adapted to the targeted recovery rate of light hydrocarbons: a preferred temperature range is -35 to +40°C.

This device also allows to produce, at the top of absorber C1 via line 7, a gas that is high in hydrogen and low in light hydrocarbons.

In summary, the device according to the invention comprises at least one absorber, at least one separator from which is extracted a gaseous phase that feeds the absorber, at least one recycling to said cold separator of at least a portion of the liquid effluent obtained from the absorber mixed with the feedstock, at least one cooling means of said recycling, at least one means for recovery of a light hydrocarbon-enriched liquid fraction obtained from said cold separator and at least one means for evacuation of gases from the absorber.

Said device can optionally further comprise a fractionation column allowing fractionation the light hydrocarbon-enriched liquid fraction obtained from the cold separator and at least two fractions.

According to a variant of the process according to the invention, the light hydrocarbon-enriched liquid fraction obtained from the absorber is also partly recovered without being recycled in the cold separator, and optionally the light hydrocarbon-enriched liquid fractions obtained from the absorber and the separator are mixed.

According to a preferred variant, the separator is located under the absorber, and, more preferably, the separator and the absorber consist of two sections superposed inside the same piece of equipment.

The device according to the invention can optionally further comprise a recycling of the liquid fraction obtained from the separator and at least one means for cooling said recycling. In addition, it can optionally further comprise cooling systems.

According to a very preferred variant, said device further comprises a fractionation column allowing fractionation the liquid effluent obtained from the cold separator into at

least 3 fractions, one of which constitutes at least in part the liquid phase recycled to the absorber.

According to another embodiment, said device further comprises at least one exchanger allowing to exchange the calories between the liquid phase obtained from the cold separator and the liquid phase recycled to the absorber after fractionation in the column. It can optionally further comprise at least one pump helping in the recirculation of at least one liquid flow.

The light hydrocarbon-enriched effluent is preferably collected directly at the outlet of the cold separator or optionally at a lateral outlet of the fractionation column, and the purge gas of the column is preferably recycled to the absorber.

Furthermore, the device according to the invention is generally placed downstream from a conversion unit, preferably a unit for hydrogenation, hydrotreatment, hydroconversion, isomerization or cracking. The different variants or embodiments of the device described in this application can optionally advantageously be at least partly combined with one another.

The invention also relates to a process for recovery of a hydrogen-rich gas using the device according to the invention or a process for recovering a hydrocarbon-enriched liquid using said device.

## CLAIMS

1. Apparatus comprising at least one absorber, at least one cold separator from which is extracted a gaseous phase that feeds absorber, at least one means for recycling to said cold separator of at least a portion of liquid effluent obtained from the absorber and mixed with feedstock, at least one cooling means for cooling recycled liquid effluent, at least one means for recovery of a light hydrocarbon-enriched liquid fraction obtained from said cold separator and at least one means for evacuation of gases from absorber.

2. Apparatus according to claim 1 or 2, further comprising a fractionation column for fractionating light hydrocarbon-enriched liquid fraction obtained from cold separator into at least two fractions.

3. Apparatus according to claim 1 or 2, wherein said light hydrocarbon-enriched liquid fraction obtained from absorber is also partly withdrawn without being recycled to cold separator.

4. Apparatus according to claim 3, wherein the light hydrocarbon-enriched liquid fractions obtained from absorber and separator are mixed.

5. Apparatus according to any one of claims 1 to 4, wherein said separator is located under said absorber.

6. Apparatus according to any one of claims 1 to 5, wherein said separator and said absorber comprise two sections that are superposed inside the same piece of equipment.

7. Apparatus according to any one of claims 1 to 6, further comprising means for recycling the liquid fraction obtained from the separator and at least one cooling means for cooling the recycled liquid fraction.

8. Apparatus according to any one of claims 1 to 7 further comprising cooling systems.

9. Apparatus according to any one of claims 1 to 8, further comprising a fractionation column for fractionating the liquid effluent obtained from cold separator into at least 3 fractions of which one constitutes at least partly the liquid phase that is recycled to absorber.

10. Apparatus according to any one of claims 1 to 9, further comprising at least one exchanger for exchanging heat between liquid phase obtained from cold separator and liquid phase recycled to absorber after fractionation in the column.

11. Apparatus according to any one of claims 1 to 10, further comprising at least one pump for the recirculation of at least one liquid flow.

12. Apparatus according to any one of claims 1 to 11, wherein the light hydrocarbon-enriched effluent is collected directly at the outlet of the cold separator.

13. Apparatus according to any one of claims 2 to 12, wherein the light hydrocarbon-enriched effluent is collected at a lateral output of the fractionation column.

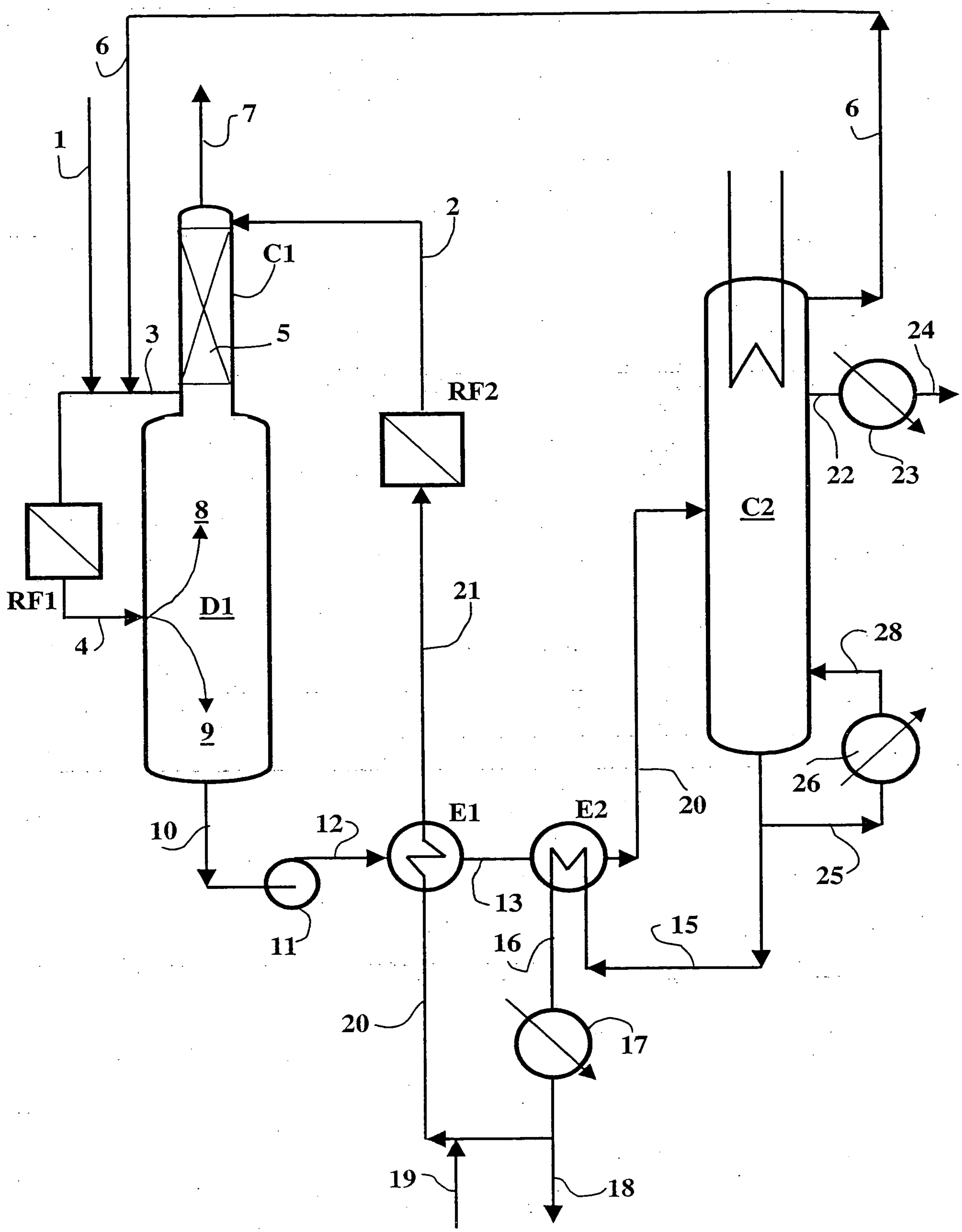
14. Apparatus according to any one of claims 1 to 13, located upstream or a conversion unit.

15. Apparatus according to claim 14, wherein the conversion unit is a unit for hydrogenation, hydrotreatment, hydroconversion, isomerization or cracking.

16. Apparatus according to any one of claims 2 to 15, wherein the purge gas from the column is recycled to the absorber.

17. A process for recovery of a hydrogen-rich gas using the apparatus according to any one of claims 1 to 16.

18. A process for recovery of a hydrocarbon-enriched liquid using the apparatus according to any one of claims 1 to 16.



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